

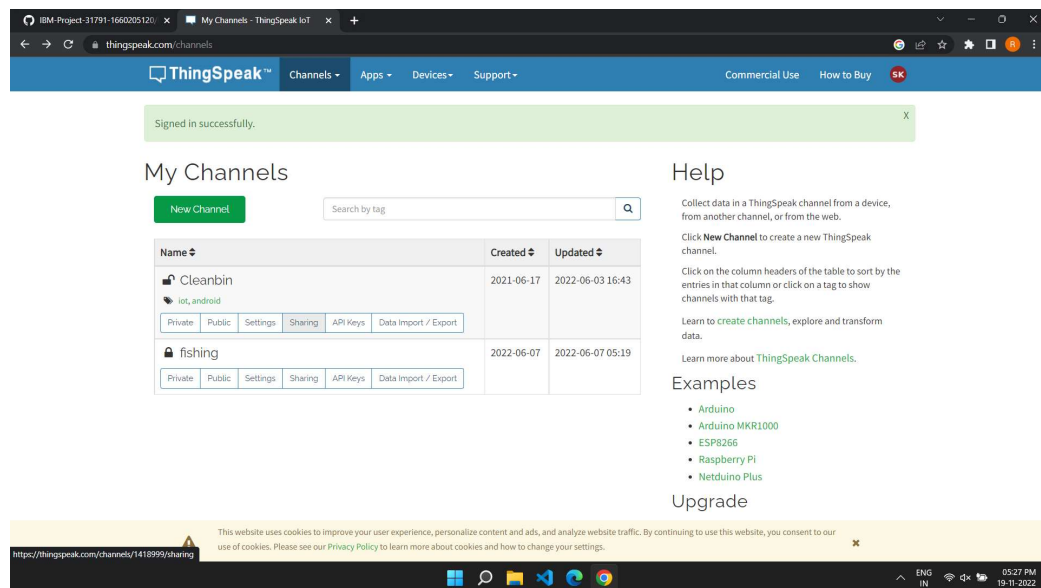
SPRINT 3

Team ID	PNT2022TMID21469
Project Name	Smart Waste Management System For Metropolitan Cities

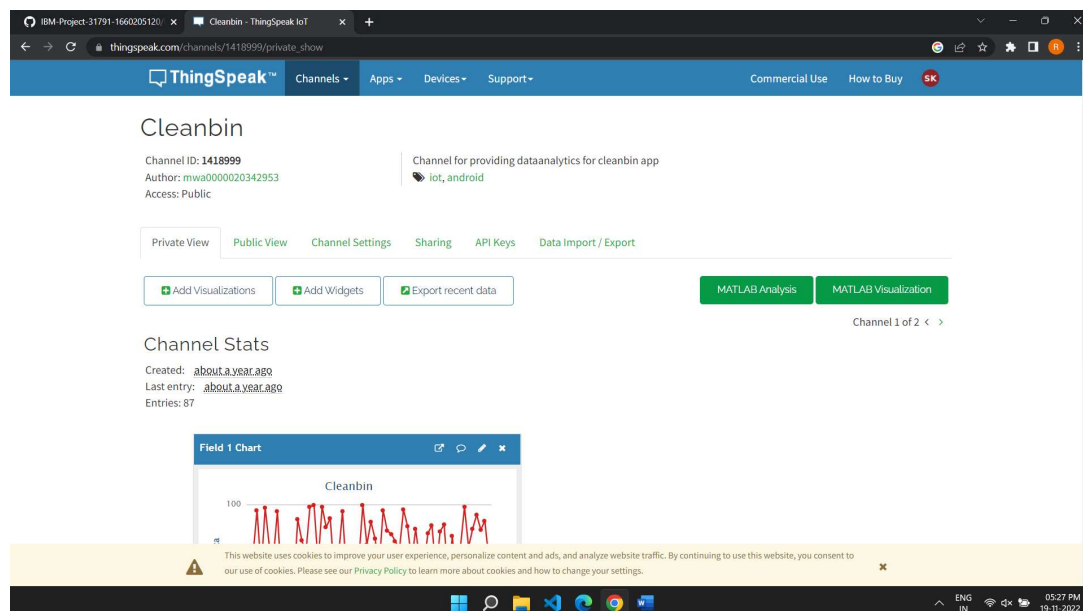
As an extra innovative functionality we have decided to implement a feature that will forecast the level of the bin that is expected to be filled in the next hour.

Since **Stream Analytics in IBM** has been **deprecated** and stream analytics is not available for (Lite / Student) plans in **IBM Watson IoT** we have used a free streaming platform **ThingSpeak**.

The data from the SmartBin is sent to the ThingSpeak server. We have created a channel for it.



We have also sent some data to the channel and tested it.



We have deployed a MATLAB code in the ThingSpeak channel which performs a Time Series analysis on the stream data in the channel.

The code has been attached in the directory.

The image displays two screenshots of the ThingSpeak MATLAB editor interface, showing the deployment and update of a MATLAB code for Time Series analysis.

Top Screenshot: The interface shows the MATLAB Code editor with the following code:

```
1 import matlab.net.*
2 import matlab.net.http.*
3 [X,T] = thingSpeakRead(1418999,'Fields',[1],'NumPoints',85)
4
5 T=unzcell(X');
6 trainFcn = 'trainlm';
7 feedbackDelays = 1:10;
8 hiddenLayerSize = 10;
9 net = narnet(feedbackDelays,hiddenLayerSize,'open',trainFcn);
10
11 [x,xi,ai,t] = preparets(net,[],[],T);
12
13 net.divideParam.trainRatio = 70/100;
14 net.divideParam.valRatio = 15/100;
15 net.divideParam.testRatio = 15/100;
16 net.trainParam.showWindow = 0;
17
18 [net,tr] = train(net,x,t,xi,ai);
19
20
21 y = net(x,xi,ai);
22 e = gsubtract(t,y);
23 performance = perform(net,t,y);
24
```

The right sidebar shows the channel information for the selected channel (Channel ID: 1418999):

- Name: fishing
- Channel ID: 1760335
- Access: Private
- Read API Key: TWNTK8YYQA7XL09U
- Write API Key: 9SV7SUAIE9GA12AG
- Fields: 1: dist

Bottom Screenshot: The interface shows the MATLAB Code editor with the following code:

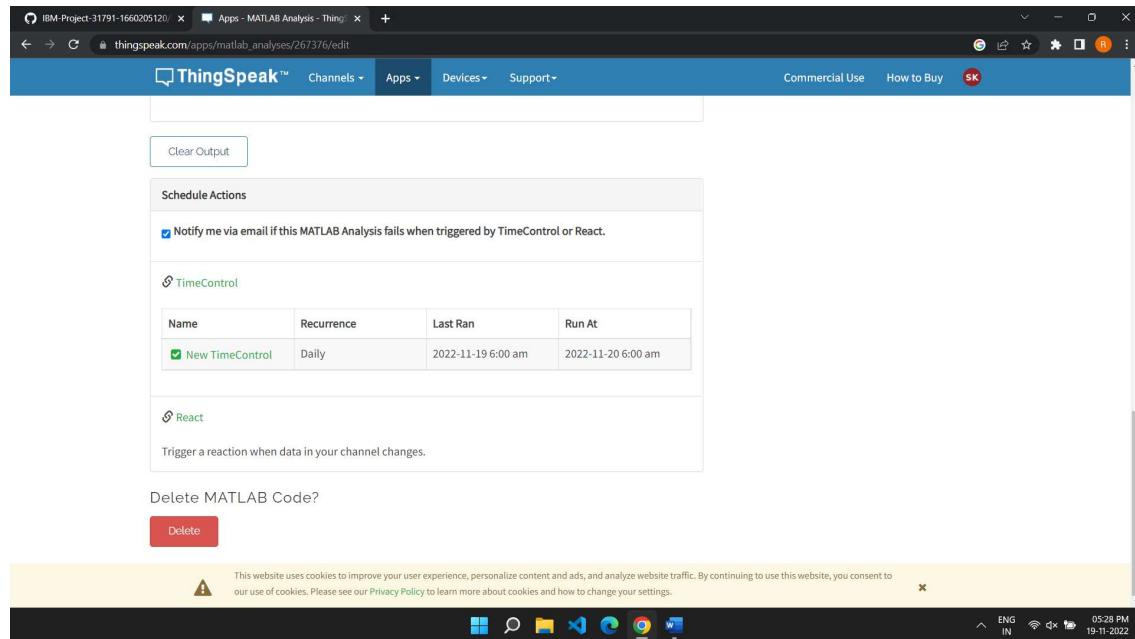
```
17 [net,tr] = train(net,x,t,xi,ai);
18
19
20 y = net(x,xi,ai);
21 e = gsubtract(t,y);
22 performance = perform(net,t,y);
23
24
25 nets = removedelay(net);
26 nets.name = [net.name ' - Predict One Step Ahead'];
27
28 [xs,xis,ais,ts] = preparets(nets,[],[],T);
29 ys = nets(xs,xis,ais);
30 stepAheadPerformance = perform(nets,ts,ys);
31 b = stepAheadPerformance / 10^floor(log10(stepAheadPerformance))
32 var=b;
33
34
35 r = RequestMessage;
36 str1='https://node-red-xtknf-2022-10-10-eu-gb.mybluemix.net/updateforecast?val='
37 str2=string(var)
38 str=append(str1,str2)
39 uri = URI(str);
40 resp = send(r,uri);
41 status = resp.StatusCode
```

The right sidebar shows the channel information for the selected channel (Channel ID: 1418999):

- Name: Cleanbin
- Channel ID: 1418999
- Access: Public
- Read API Key: 441V3CPZ2PF L61RA
- Write API Key: 00Q80HB1NQ828Y78
- Fields: 1: data

The bottom screenshot also shows the "Output" section, which is currently empty.

The MATLAB analysis has been scheduled to run in frequent intervals of time (similar to a CRON JOB in UNIX), thus forecasting the level of waste in the bin.



The details of the algorithm are,

ALGORITHM USED : Time Series prediction algorithm using Deep Learning Neural networks

Neural Network used : Non-Linear Auto-regressive Neural Network

We have trained a nonlinear autoregressive (NAR) neural network and predict on new time series data. Predicting a sequence of values in a time series is also known as *multistep prediction*. Closed-loop networks can perform multistep predictions. When external feedback is missing, closed-loop networks can continue to predict by using internal feedback. In NAR prediction, the future values of a time series are predicted only from past values of that series.

Training Data : 70 %

Testing Data : 15 %

Validation Data : 15 %

Diagrammatic representation of the neural network :

